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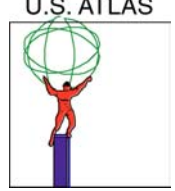
BNL Role in US ATLAS



Construction/Installation

Commissioning/ATLAS Upgrade

David Lissauer

DOE Annual HEP Review

Brookhaven National Lab

April 22, 2004

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BNL's Role in ATLAS

U.S. ATLAS

- **BNL Role in ATLAS** — H. Gordon
  - Physics & Analysis Center
  - BNL Role US ATLAS Management
- **Construction/Installation/Commissioning/ ATLAS Upgrade** — D. Lissauer
  - Construction:
    - Liquid argon calorimeter
    - Cathode strip chambers for the Muon system
  - Installation & Commissioning
    - ATLAS Technical coordination
    - LAr, Muons
  - ATLAS upgrade – Tracking/Calorimeter/Muons
- **Software and Computing** — S. Rajagopalan
  - Tier I Center
  - Core Software
  - Subsystem Specific
  - Analysis

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General Approach

U.S. ATLAS

- Construction responsibility matched to unique technical development at BNL.

  Based on pioneering work in Physics Dept. & Instrumentation Division for both LAr calorimeter and cathode strip chambers.
- Analysis work builds on the detector expertise in the calorimeter and muon systems.
- ATLAS upgrade will concentrate on Tracking system, taking advantage of on going R&D and unique developments at BNL.

Cryostat & Feedthroughs

- **Barrel cryostat** — **J. Sondericker, *D. Lissauer***
- **Feedthroughs** — **T. Muller, B. Hackenburg**

- Production started March ‘99 at KHI. Arrived at CERN and accepted by ATLAS by Aug ’01.
- Feedthrough production factory and test facility set up at BNL.
- All 64 FTs welded to cryostat, and fully checked in March ’02.
- EM Calorimeter installed in the Cryostat in ’03 and Cold vessel was welded shut by end of ’03.
- Solenoid installed the Cryostat Vacuum in early ’04.

- Vessel cool down procedure started April ’04 cold test expected to be completed by Sept ’04.
- Transport to the Experimental Hall Sept ’04.
- Move to final position June ’05. (Limited by Toroid Installation Schedule)

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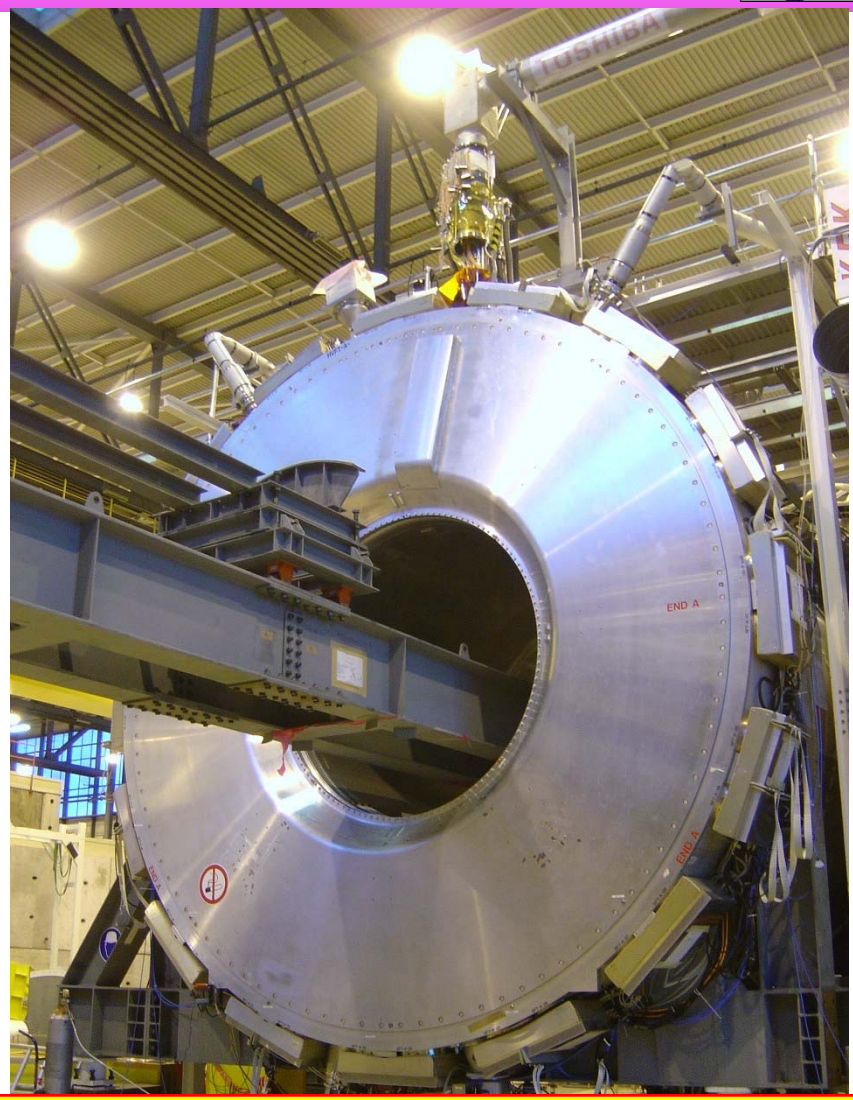
U.S. ATLAS

Barrel Cryostat

Warm Flange being installed.



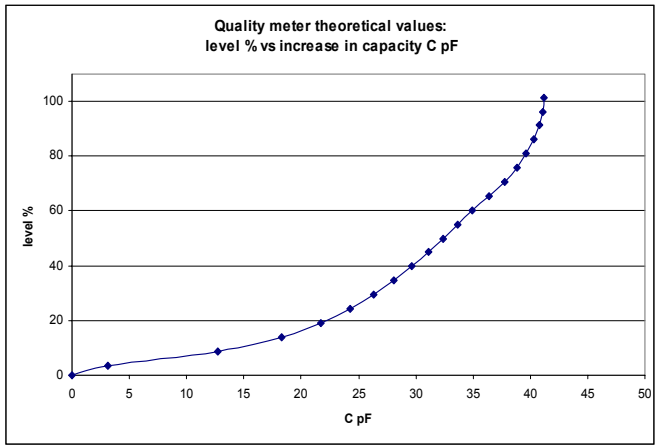
Vessel Shut – Solenoid installed.

Cryogenics

- **Responsibility:** Refrigerator, Dewar, Quality Meters, Control System
  J. Sondericker , D. Lissauer

- Contract Air Liquide for: Refrigerator , Nitrogen Dewar
  - Compressor & Valve Boxes delivered at CERN and passed preliminary test
  - Dewar delivery delayed (Air Liquid) delivery May ’04.
- Quality Meter (Built at BNL)
  - Shipped to CERN ’03.
- Control system
  - Functional analysis and programming for N_2 control.
- System acceptance tests
  - Full system expected Sept. ’04.
- First cool down of Calorimeter in the Pit ’05.

Q-Meters testing



Y. Farah putting the finishing touches to the Capacitance to current conversion boards which read out the Q Meter signals.

All Q meters are now complete, thoroughly checked out and calibrated.

First meters being used in West area cool down tests.

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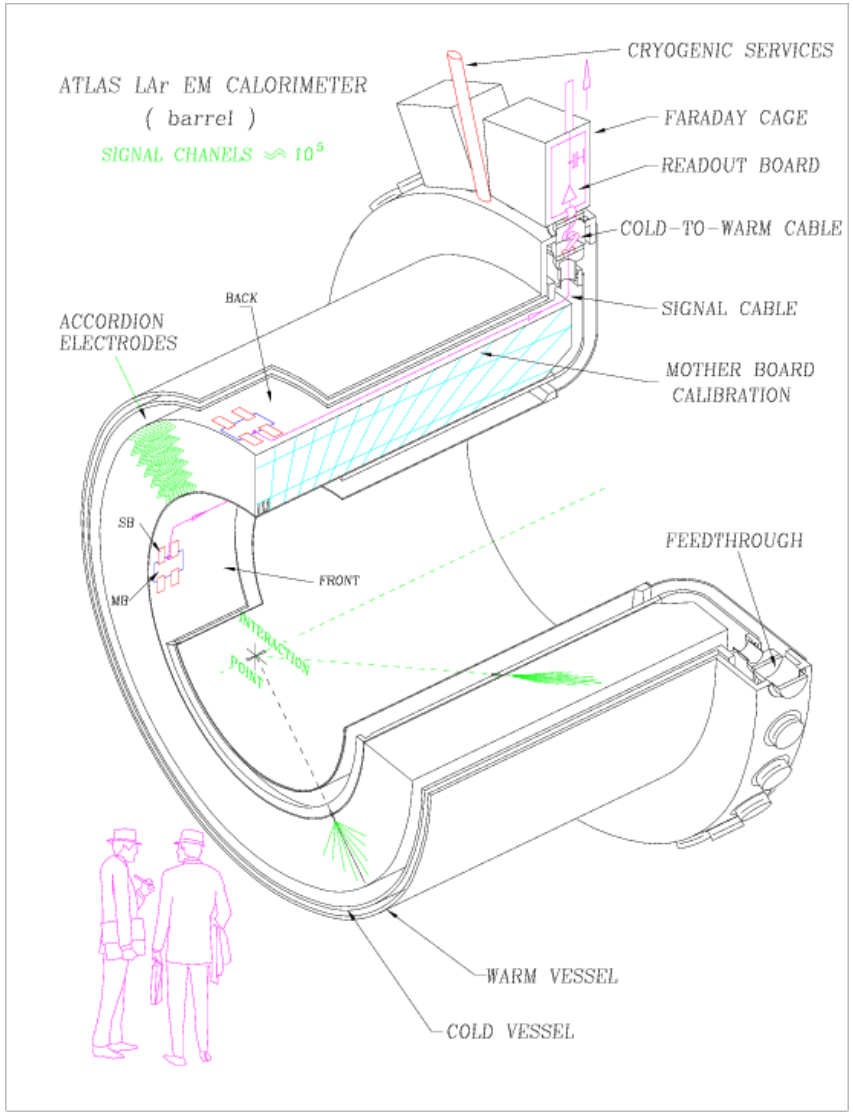
LAr Readout

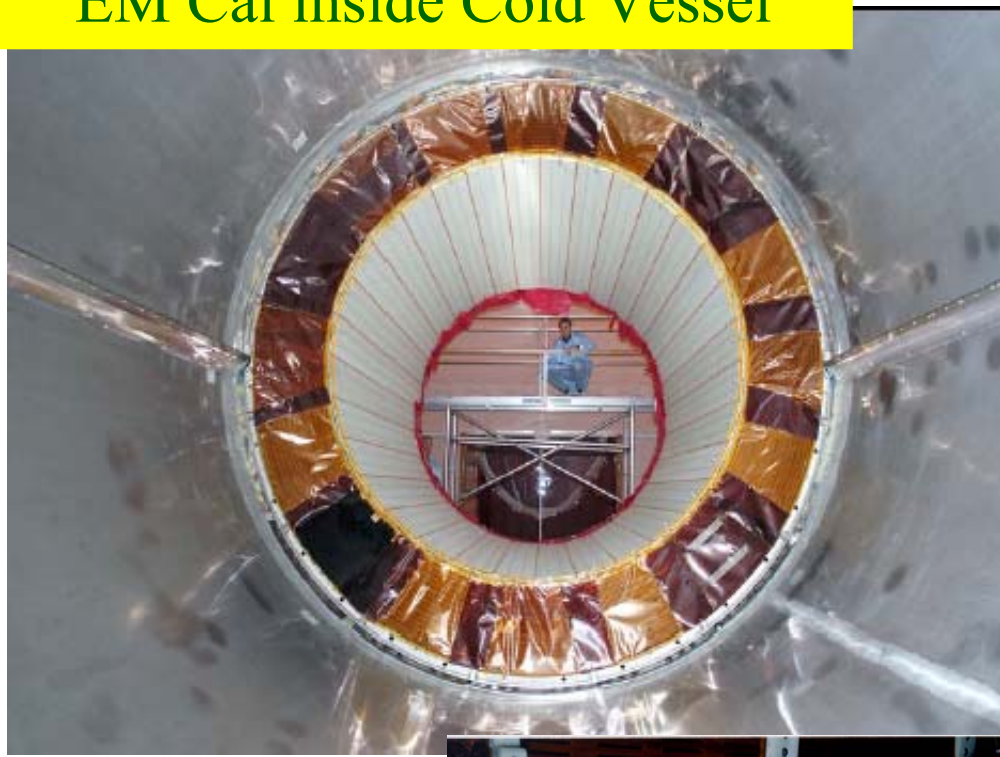
U.S. ATLAS

- Electrodes
- Motherboards (cold elec.)
- System crate: on detector electronics
  - Preamps
  - Monitoring Board
  - Warm cables
  - Base-plane – analog trigger sums.
  - Pedestal and Crate
  - Cooling system
  - Rad-hard power supply
- Integration of front-end electronics



EM Barrel Modules

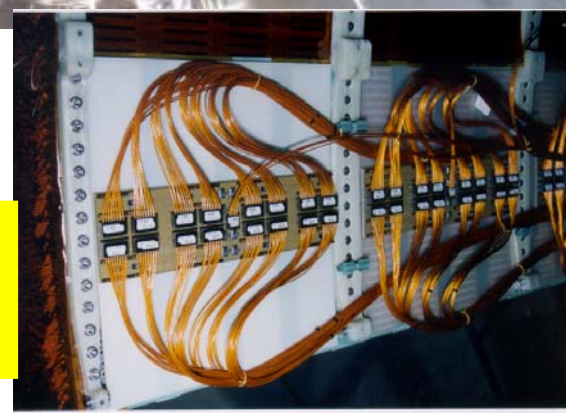
EM Cal inside Cold Vessel



S. Rescia (Eng.), S. Rajagopalan,

- Large electrodes Design & Production. (Completed)
- Motherboards (Completed)
- EM Modules using BNL designed electrodes and Motherboards completed in early ’03.
- EM barrel has been inserted into the cryostat and cryostat was welded “shut” end of ’03.

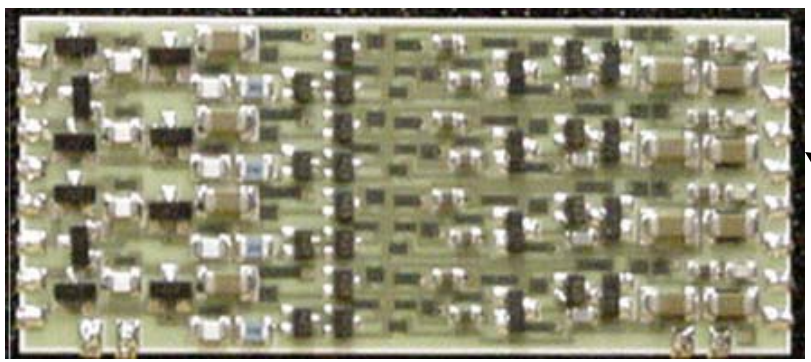
Motherboards on the EM Cal.



Preamps

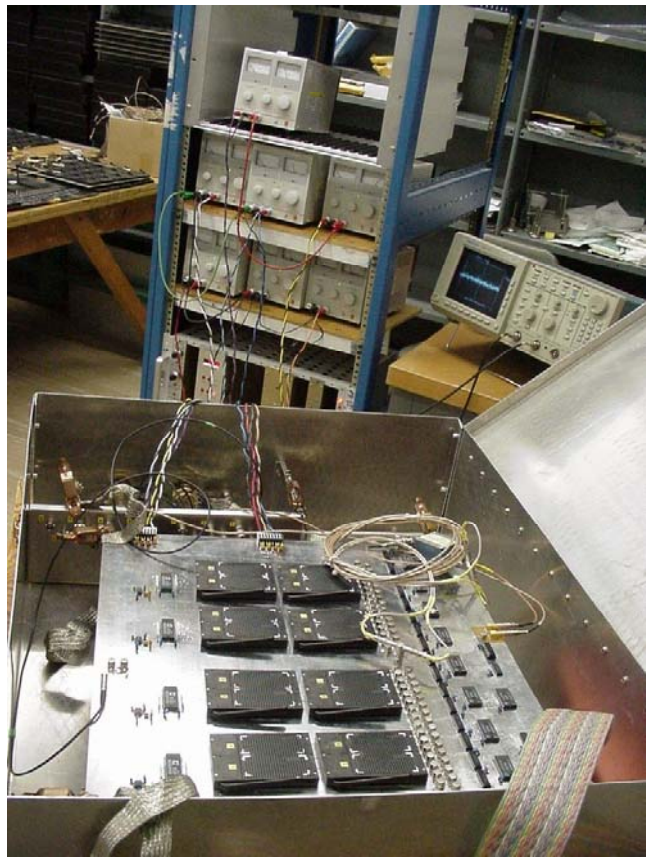
- **Persons Responsible:** J. Kierstead (Eng.), H. Ma
- **Responsibility:** 120k channels of Preamps (½ LAr Calorimeter), Participate in installation

- Designed by BNL and Milano
  - Low noise, high dynamic range
- 3 types of hybrids,
  - 4 channels/hybrid, 30,000 total
- Automated tests at BNL
- Preamps production started Feb 2001
- Completed in Sept 2002,
  Ready to be installed in Front-end Boards.



hybrid

Test setup



Crate Assembly & Integration

- **Persons Responsible:** F. Lanni, T. Muller and S. Norton
- **Institutions:** BNL (Barrel) , Milano (EC)
- **Responsibility:** All Barrel and EC electronics crates

Production and Integration of Electro-Mechanical part of the Front End Crate System:

- Warm cables, Pedestal and Base-planes
  - Production and installation completed on Barrel and EC in ’03.
- System Crates.
  - Production and assembly complete at BNL.
  - Installation starts ’05.
- Cooling System
  - Passed PRR in Early ’04.
  - In production now. (T. Muller/F. Lanni)
- Crate Monitoring
  - Passed PRR in Early ’04
  - In production now. (H. Chen/F. Lanni)
- Integration in the Experiment.
  - Design and interaction with Technical Coordination to define all interfaces.

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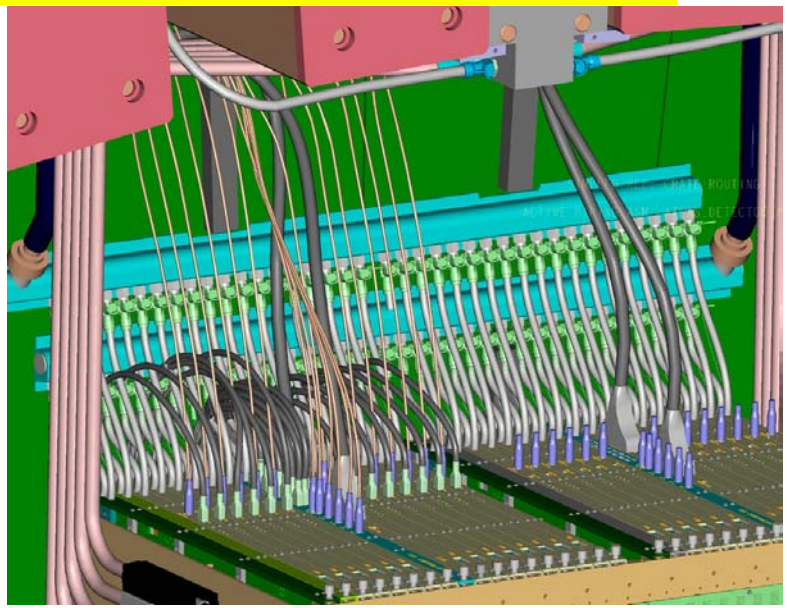
Mockup

BNL System Test Lab.

CERN Mechanical Mockup



Detail Design of LAr Services and Installation Plan. (BNL)

Power Supply

- **Persons Responsible:** F. Lanni, J. Kierstead (Eng.)
- **Institutions:** BNL
- **Responsibility:** All LAr Front End Power Supplies.

- **3.2 kW Power**
- **Radiation Levels of 50 KRads.**
- **Critical Space Limitations.**
- **High Reliability (N+1 Design)**

- **Development and tests Completed in '03/'04.**
  - Radiation tests completed on components
  - Gamma, proton, and neutron radiation with less than 1% variation observed
  - Production prototype finished by end 2003

- **Contract signed for Power Supplies with MDI April '04.**

Open PS.

16x30x30 cm

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Front-End System Test

U.S. ATLAS

- **Person responsible:** **F. Lanni, H. Chen; S. Rescia, D. Makowiecki (Eng.)**
- **Institutions:** **BNL**
- **Responsibility:** **Full front-end electronics system integration**

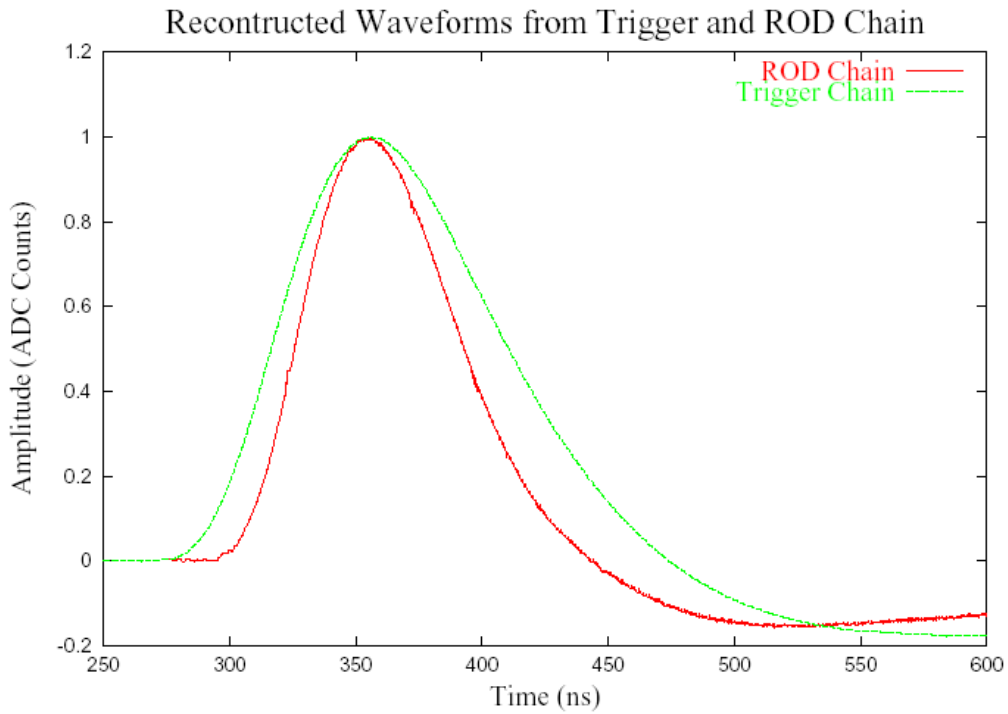
- F. Lanni is the LAr Front-End Electronics Coordinator

- FEC system test system at BNL:
  - Unique in ATLAS for LAr Calorimeter
  - Integration of power supply, cooling, ROD, DAQ, analysis and people
  - Test for dynamic range, linearity, coherent noise, crosstalk.
  - Preparation for FEB production tests.

- System validation of FEC for All components
  - EM-Barrel, EM-Endcap, Hadron Cal, Forward CAL
  - Prove system performance
  - Debug installation procedures
  - Identify possible critical points.

FEC Test Activities

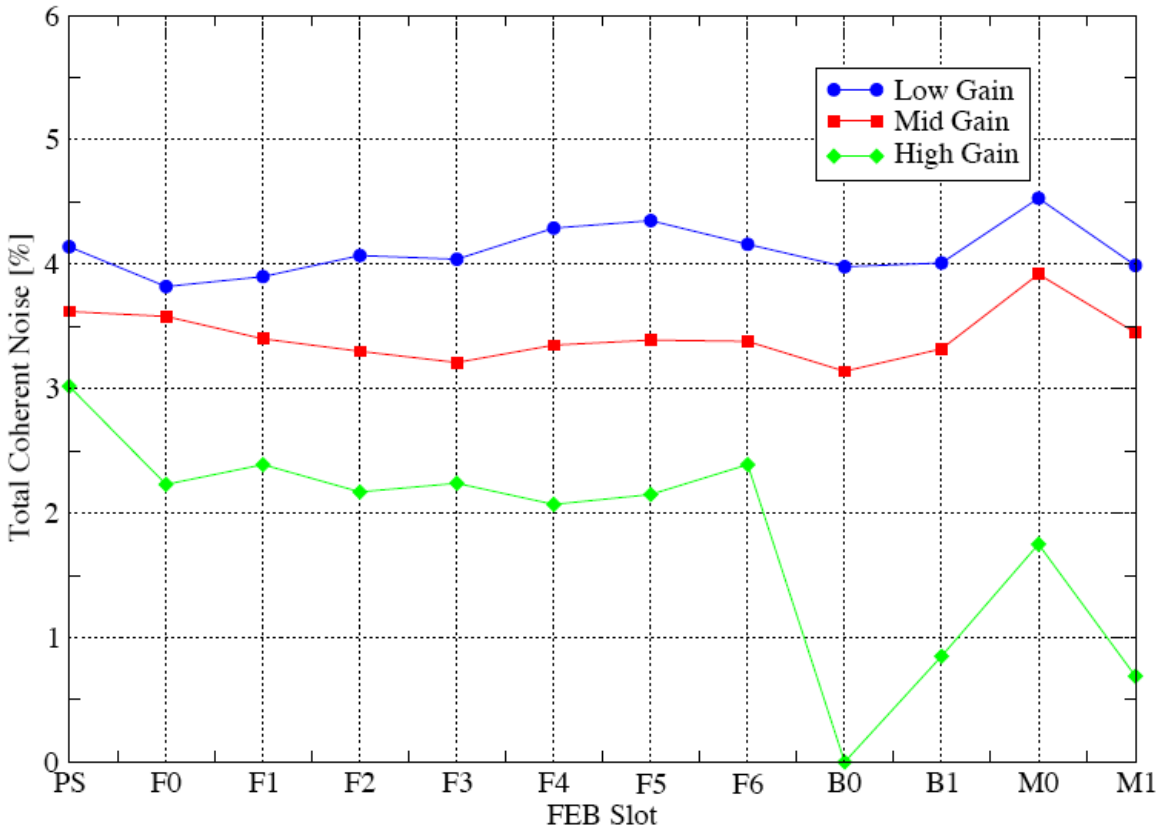
- Many collaborators have come to test components:
  - Annecy, Orsay, Saclay, Paris VI, Pittsburgh, Stony Brook, Nevis
- Full system has been installed successfully and tested at BNL.
- Online software integration



Crate Test Completed in Early '04 Successfully!!!!

Green light for production of FEB, PS, Calibration Boards etc.

Coherent Noise Measurements



Summary of coherent noise (as % of the random noise/channel) for each of the 14 FEB in the FEC test

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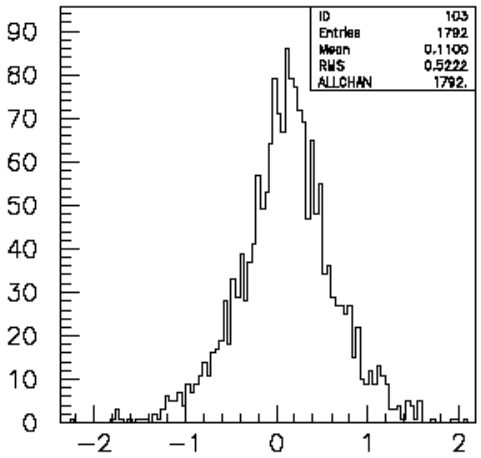
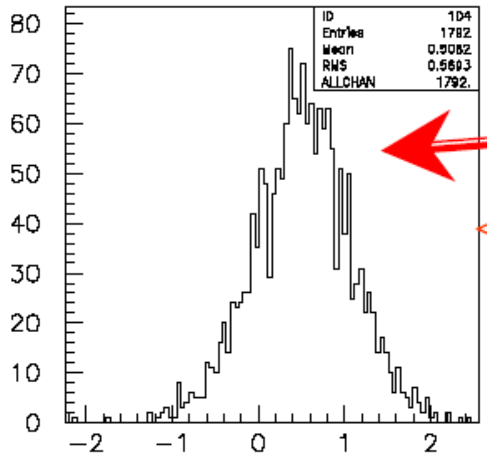
Long Term Stability Tests

U.S. ATLAS



Change in pedestal Jan. 8 – Feb. 1

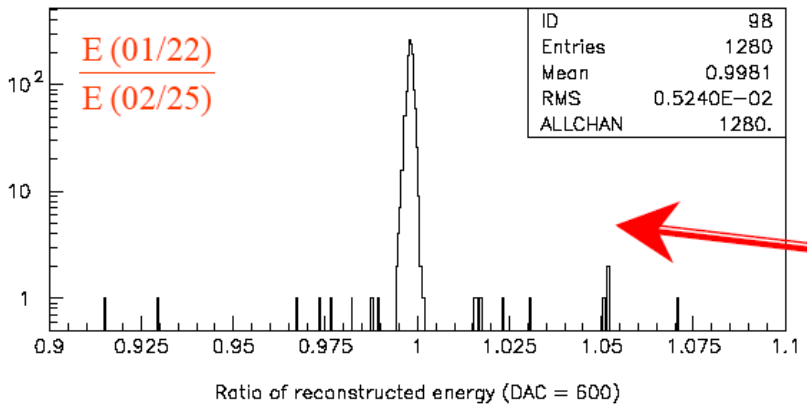


Change in pedestal Jan. 8 – Feb. 8

$\Delta t = 1$ month

$< \Delta(\text{ped}) > = 0.5$ ADC cnts

RMS = 0.6 ADC cnts



using OFCs from Jan. 22

10 FEBs (1280 chan) avail.

Mean = 0.998

RMS = 0.005

Long term stability (pedestals and gain [amplitude reconstruction])

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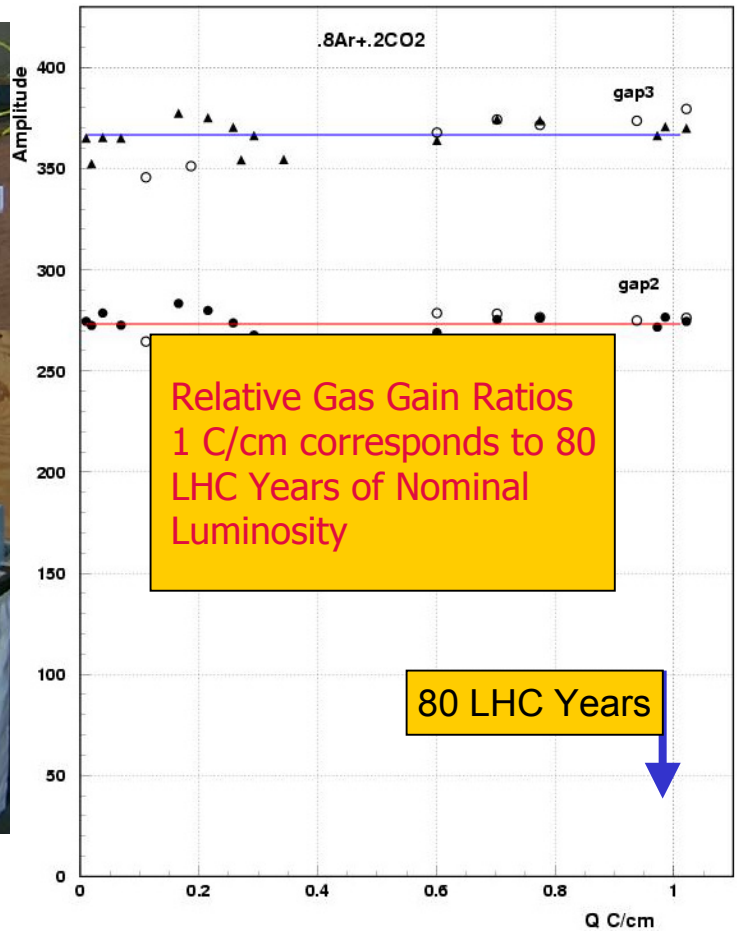
LAr Next Steps

U.S. ATLAS

- Effort started to shift from production to installation and commissioning.
- Cryogenics:
  - installation and commissioning in ’04 and ’05.
- Barrel Cryostat:
  - Cold test in ’04 (cool down started)
  - Installation in the Pit in ’05
- Electronics:
  - Electronics installation in the pit in ’05-’06
- Commissioning:
  - Using Calibration system start end of ’05.
  - Using Cosmic Rays – full readout system ’06.

CSC Construction Status

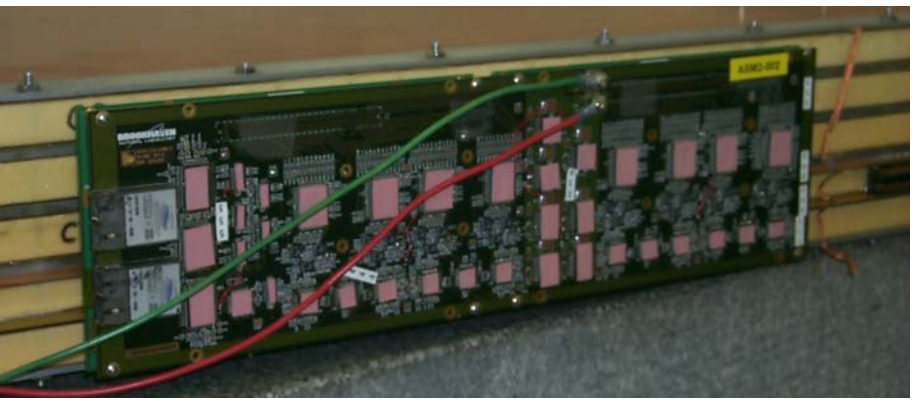
- **Construction of all 32 chambers has been completed**
- **Successful Aging Test with ^{60}Co source equivalent to ~100 LHC Years**



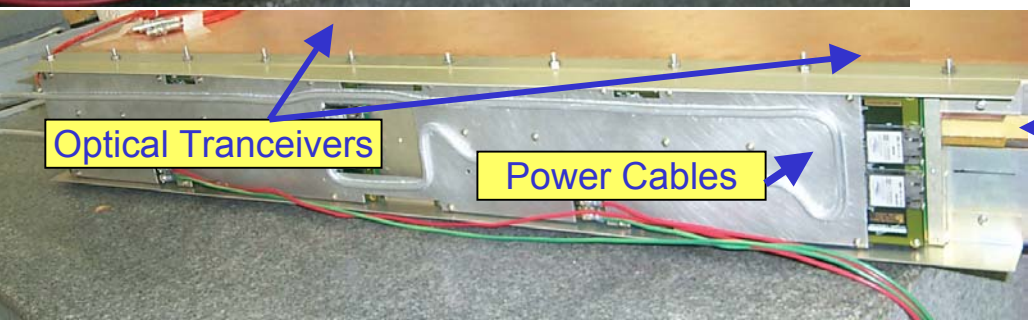
16 Chambers kept in an Nitrogen atmosphere awaiting readout electronics

Status of CSC Electronics

- All Custom Chips available and Radiation qualified
- Readout Electronics in final stages of testing
- Production to start end of next month
- Mounting on Chambers, testing to the end of the year
- ATLAS Installation Schedule for CSC: May 2006



Front end Electronics Pack: 192 Channels, 5 such packs per chamber, digitized signals to counting room via optical fibers



- 2 ASM Packs: 384 Channels in faraday cage with cooling
- Power cables and Optical Fibers the only connections to the Chamber for better noise immunity

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Technical Coordination

U.S. ATLAS

D. Lissauer , A. Gordeev, S. Norton, R. Ruggerio

TC Activity A (Project Office) Manager

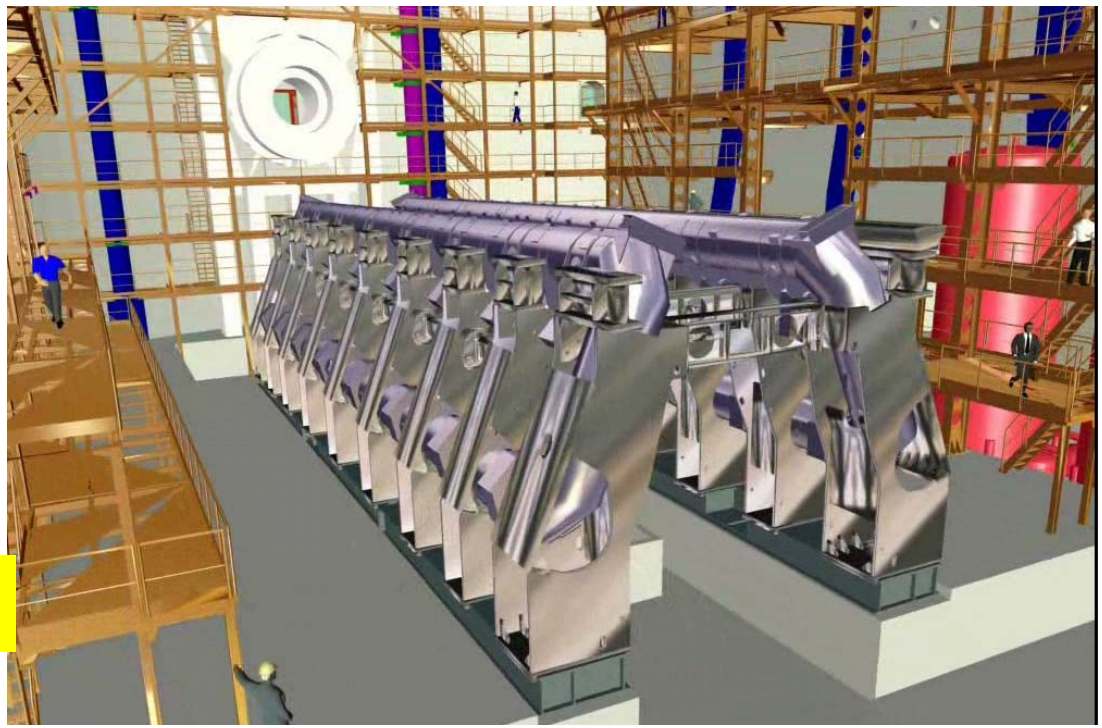
ATLAS Technical Management Board

Coordinator US ATLAS TC: (Arizona, BNL, ANL, LBNL and Boston)

Configuration Control

Services Routing

Access



October '04

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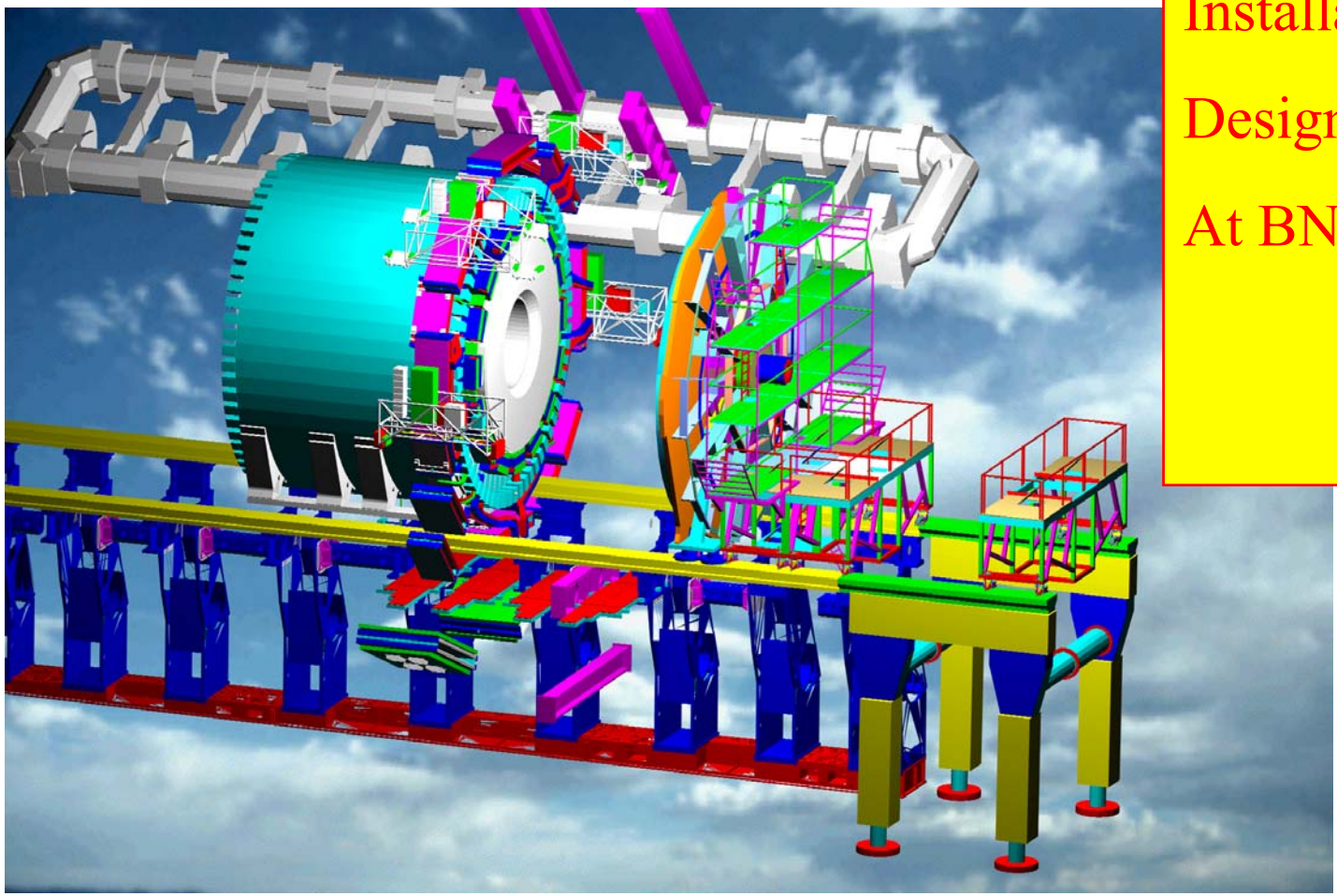
ID Installation Tooling

U.S. ATLAS



Installation tooling

Design by A. Gordeev

At BNL.

LHC upgrade

- Consider LHC Luminosity upgrade
  - SLHC : $L = 10^{35}$ /cm^2 /s
  - Bunch crossing: 25ns → 12.5ns
  - No. interactions/Crossing: 20→100
  - Radiation: X10
  - Rates: X10
- We are studying detector upgrade for Inner Tracker , LAr Calorimeter, Forward Muons
  - Radiation tolerance
  - Rate capability
  - Pattern recognition capability

Inner Tracker

- D. Lynn, D. Lissauer (Physics)
- Z. Li, P. O'Connor,

V. Radeka (Instrumentation Division)

Development of Single Sided 2D detectors.

Cost Effective Large Area Detectors.

Material Studies: High Radiation levels needed for LHC.

Geometrical Configuration: Optimization of granularity and shape.

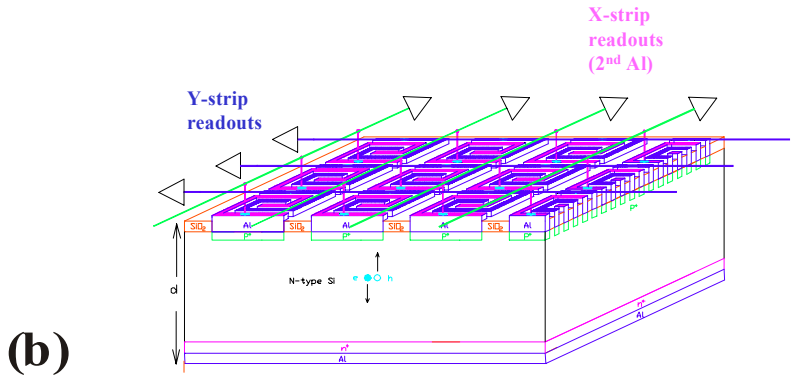
Industrial Production: Establish contracts with Si manufacturers.

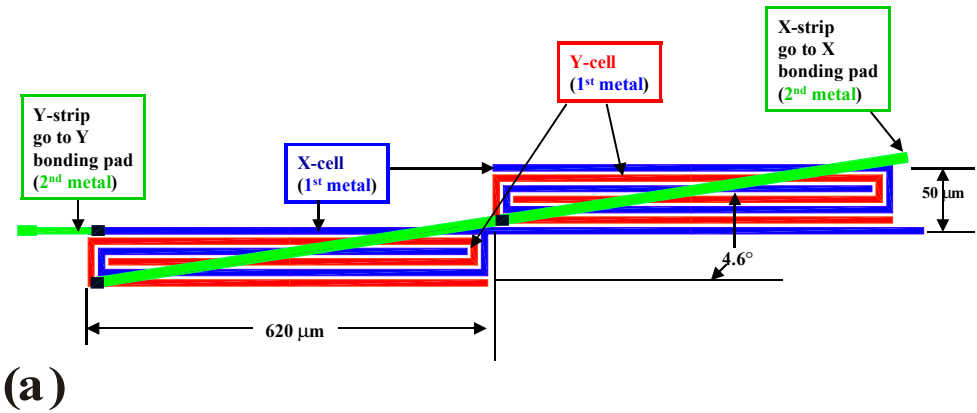
A possible detector configuration for US ATLAS Upgrade

Pixel pitch: X ---- 620 μm, Y ---- 50 μm

X and Y cell line width 5 μm, gap 3.33 μm = 8.33 μm line pitch

X and Y strips stereo angle: 4.6°





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Inner Tracker R & D

U.S. ATLAS

Tracking is challenging at SLHC,

Emphasis will be on optimizing the overall system

- **Simulation:** Detector geometry, readout granularity.
- **Support Structure:** Integrated Support of the ID, "Massless".
- **Cooling:** Thermal management of the system.
- **Si Detector:** Technology, contact with industry.
- **Readout:** Technology, Power, Connections.
- **Module Layout:** Technology, Integration at the module level.
- **System Infrastructure:** Cabling, multiplexing.
- **Optical Links:** Power consideration, multiplexing, Rad hard.
- **Power Supplies:** Location, distribution, cabling.
- **Radiation Hardness:** Radiation hardness of ALL components.
- **System Tests:** Validation of the performance at the system level.

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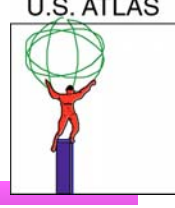
Summary

U.S. ATLAS



- ATLAS detector construction at BNL is well underway, expect to complete all major construction by ’05. ON COST/SCHEDULE
- Significant effort started and will grow in system integration and commissioning of the ATLAS Detector, including efforts in the Subsystems as well as in Technical Coordination. BNL leads the U.S. effort.
- Work has started on LHC upgrade R&D. We expect that this will lead to a proposal in 3-4 years for a new tracker and an upgrade to the present calorimeter and forward muon systems.